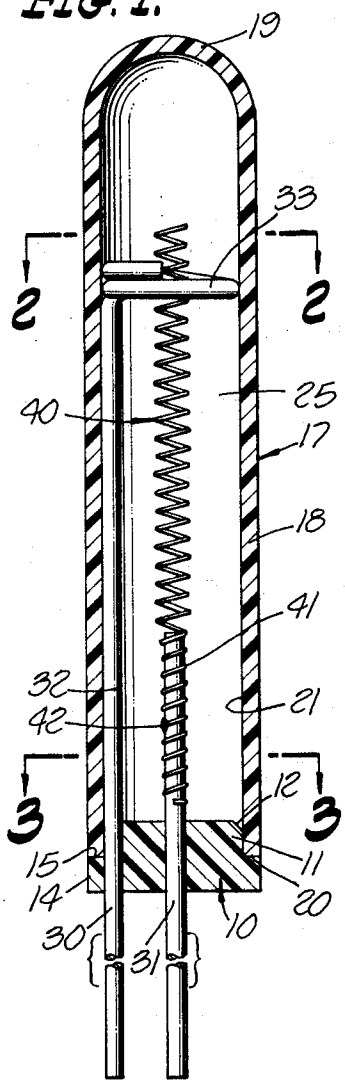
March 24, 1970 L. H. McROSKEY 3,502,832

FORCE RESPONSIVE SWITCH

Filed Feb. 3, 1969

FIG. 1.



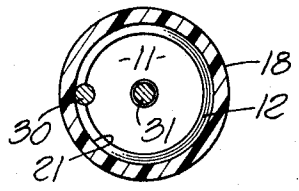


FIG. 3.

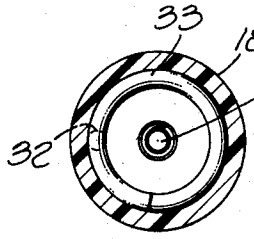
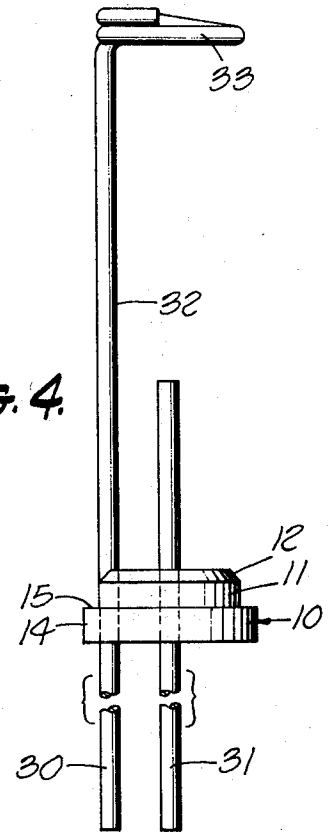


FIG. 2.

FIG. 4.



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FORCE RESPONSIVE SWITCH

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U.S. Cl. 200—61.49 5 Claims

ABSTRACT OF THE DISCLOSURE

My invention consists of a force responsive switch having a dielectric envelope and a dielectric base providing an argon filled chamber, the chamber enclosing a ring contact engaging the envelope and having an electrode extending to the exterior of said chamber, and a resilient elongated pendulous contact extending through the ring and supported by the base, said pendulous contact having an electrode extending to the exterior of said chamber.

BACKGROUND OF THE INVENTION

The present invention relates to a force responsive switch which makes and breaks an electric circuit in response to various forces such as gravity, inertia, centrifugal or vibration producing forces.

In the prior art, it is noted that United States Letters Patent No. 2,996,586 discloses a magnetic switch having a body of the order of one inch in length in which a rod between a pair of magnets is supported by the magnets in spaced relation to angular contact members adjacent to the ends of the rods.

Also in a copending application in which this inventor is one of the coinventors there is a disclosed switch which is designed for the particular use referred to herein. This application is identified as the application of James A. Carley, Leonard H. McRoskey, and Robert Q. Parsons, Ser. No. 679,098 filed Oct. 30, 1967. Switches of this prior invention have proved highly satisfactory in the service. Their functioning has been superior to all other prior art known to applicant or to applicant's customers. In the manufacture of these glass enclosures of the tumbler switch of the prior invention they are basically a hand operation and production is necessarily at a relatively slow rate.

In manufacture, heating glass to the melting point in order to form a homogeneous bond often results in a rejected part. This is caused by the soft plastic state of the glass which often upsets the critical tolerances of the contact elements. Difficulty is experienced in fixturing various elements of the switch to produce absolute uniformity in the switch unit thereby necessitating an individual test of each switch to determine its operating parameters. Also the application of heat upon the glass enclosure to effect a bond between the base bead and the glass tube at times distorts the terminals and oxidizes the plating on the terminals.

SUMMARY OF THE INVENTION

In the force responsive switch of my present invention all of the manufacturing difficulties experienced with the invention disclosed in the application referred to above have been eliminated with the result that there is uniformity in production which reduces rejects to a very minimum and there is also economy in the manufacture and assembly of the parts. By reason of the details of the present invention precise positioning of the contact terminals within the base is difficult, the leads being molded into position when the base is cast. There is precise fixturing of parts during the manufacturing process thereby eliminating the requirement to run every unit through an exhaustive test series. Elimination of heat to bond the base to the enclosure results in elimination of the difficulties where a glass enclosure must be heated to a high temperature. Automatic production is permissible because the base and envelope are precisely of the same configuration and tolerance and are fitted together exactly the same each time an assembly is made. Fixturing of all elements in assembly assures uniformity of subassemblies and uniformity in the finished switch. The production rate is increased greatly by the use of an envelope and base which may be secured together without the application of heat. Furthermore, use of different materials in the center pendulous contact is permitted because no distortion will occur because of heat concentration resulting from the sealing and bonding of a base such as glass.

BRIEF DESCRIPTION OF THE DRAWINGS

Referring to the accompanying drawings which are for illustrative purposes only:

FIG. 1 is an enlarged longitudinal sectional view of a switch made in accordance with the present invention;

FIG. 2 is a cross-sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is a sectional view taken along the line 3—3 of FIG. 1; and

FIG. 4 is an elevational view showing the manner in which the base and electrodes are assembled together as a unit prior to the adding of the pendulous contact and prior to the assembly of the base with the envelope.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the drawing the numeral **10** indicates the base which is formed from a dielectric material such as a polycarbonate resin. It is cast by a standard method. The base **10** has a cylindrical projection **11** which in the form of the invention illustrated is .125 inch in diameter and is chamfered at the top as indicated at **12**. The base **11** has a flange **14** which provides a flat upper surface **15**.

The numeral **17** is a dielectric envelope which may be made from polycarbonate resin or its equivalent, this envelope having a cylindrical portion **18** which in the form shown is .750 inch long and has an inner diameter of .125 inch. One end of the envelope **17** is closed by an integral rounded end **19** and the other end is left open and is provided with a flat end face **20**. The envelope and base are assembled together so that the inner cylindrical surface **21** of the envelope fits on the cylindrical projection **11** and the end face **20** of the envelope engages the face **15** of the base. These two parts are secured together by a suitable glue such, for example, as a polycarbonate solvent. The connection between these air parts is gas tight and enables the chamber **25** of the envelope to be evacuated and filled with an inert gas such as argon.

When the base **10** is molded electrodes **30** and **31** are molded in place, being accurately positioned by suitable fixturing and the joining of the base material and electrodes is gas tight. These electrodes are made from a suitable material such as "Dumet" which is an alloy consisting of 54% iron, 46% nickel, and copper plated. Electrode **30** is .016 inch in diameter and extends through the base on an axis which is parallel to the central axis of the base cap. The electrode **30** is positioned so that its radially outermost portion as indicated at **32** is on a diameter of .125 inch so that it will contact the inner wall **21** of the envelope **17** throughout its entire length. The extending end of the electrode **30** within the envelope **17** is formed into a ring as indicated at **30**, this ring having an outer diameter which is the same diameter as the inner cylindrical surface **21** of the envelope. In this way the portion of the electrode within the chamber **25** and the ring contact **33** are supported by the inner wall **21** of the envelope **17**. The portion of the electrode which extends downwardly from the base **10** is of suitable length so that an electric circuit wire may be connected thereto. This is also true of the electrode **31**.

The central electrode **31** is placed on the longitudinal axis of the envelope and the base and extends into the chamber **25** a sufficient distance so that a pendulous contact may be attached thereto.

There is a flexible pendulous contact **40** which when the axis of the switch is vertical extends concentric to the longitudinal axis of the envelope and base. This movable contact is in the form of a tightly wound helix or coiled spring and is made from a suitable conductive material such as tungsten wire. The diameter of the wire used is approximately .003 inch and the diameter of the helix of the spring is approximately .016 inch. The dimensions given here are those which are used where the switch is intended to respond to forces of two G's gravity in order to close the switch or, in other words, to cause the pendulous contact **40** to move into engagement with some portion of the ring contact **33**. For clarity the drawing of this application shows the coils of wire spaced apart although they are, in fact, closely wound as previously explained. It will be noted that the movable contact **40** is sufficiently long so that the upper portion projects through the ring contact **33**. As thus arranged the coil spring forms in effect a pendulous contact although it does not carry a weight at its free end.

By utilizing this construction, the coils of the spring provide throughout the length of the spring contact surfaces which are engageable with the ring contact **33** irrespective of the position of the ring contact along the length of the movable contact.

The helical spring is reduced in diameter at its lower end as indicated at **42**, this diameter being such that it will slide over the inner end of the electrode **31** so that the movable contact **40** will be supported in an accurate concentric position. The lower end **41** is secured to the electrode **31** by bonding at a point such as indicated at **42** which is spaced away from the larger diameter of the helix in order that the heat of the bonding operation which is a spot welding operation will not reach the pendulous portion of the movable contact and distort or draw its temper.

The amount of force required to close the contacts may be varied in a number of ways. For example, if the envelope **17** is of larger diameter so that the ring contact **33** may be made of larger diameter, the force required will be increased. Also the amount of closing force required is dependent upon the diameter of the helix of the pendulous contact **40**. It will also be apparent that since the contact **40** is supported in the manner of a cantilever structure the amount of deflection required to effect closure of the contact will vary depending upon the position of the ring contact **33**. In other words, it may be placed lower or higher in the envelope **17**. Also the force required to close the contact will depend upon whether the switch is vertically positioned as shown in the drawings or horizontally positioned with the axis of the envelope and base and related parts in a horizontal position; in such event, gravity will cause the pendulous contact **40** to bend downward bringing it closer to the ring contact **33** on the lower side and this, of course, will cause the contacts to engage at a lower force.

In the manufacture of the switch of my invention, the envelopes **17** are all made of a standard size; they are identical to each other for a given switch. Also the base **20** is identical in size so that each base will accurately fit the envelope. An additional important feature is that the electrodes **30** and **31** are held in a fixture and are passed through the molds in which the base **10** is molded so that these parts will be absolutely accurately positioned in the subassembly such as shown in FIG. 4.

After forming the envelope and base with the electrode in place, the next operation is to secure the pendulous electrode **40** in place and this is done as previously described. The next operation is to slide the envelope and the base together so that the parts will rest in a partly assembled position with the base slightly spaced from the lower end of the envelope. The parts are then placed in a vacuum chamber, the air evacuated, and the chamber is then filled with gas so that the chamber **25** of the trembler switch will also be filled with an inert gas such as argon. The parts are then completely assembled and the sealing operation is performed by using, for example, the polycarbonate solvent as previously referred to. The plastic parts may be coated, or plated with a non-porous material, should they be porous and permit leakage through the walls.

In operation the switch may be positioned vertically or horizontally or in some intermediate position. The electrodes **30** and **31** are connected in the electrical circuit which is used to perform the desired function, such, for example, as exploding a land mine. It will be understood, of course, that this trembler switch may be used anywhere that it is desired to close an electrical circuit in response to a vibratory force.

I claim:

1. A force responsive switch, comprising:

(a) a dielectric base;

(b) a dielectric envelope mounted on said base and fitted over a portion thereof and providing a sealed chamber;

(c) a pair of electrode terminals fixedly supported in said base; one of said electrodes extending along the inner wall of said envelope and having a ring contact in spaced relation to said base; and

(d) a resilient elongated pendulous contact supported against movement at one end on the other of said electrodes with a portion positioned within said ring and extending therethrough and including means whereby said contact engages said ring contact upon predetermined deflection thereof.

2. A switch according to claim **1**, wherein the pendulous contact has a uniform configuration transversely, and when the switch is vertically positioned will have its longitudinal axis centered within said ring, and upon the switch being horizontally positioned will have its axis more closely spaced to one side of said ring.

3. A switch as defined in claim **1** in which said envelope has a cylindrical portion and in which said ring contact is annular and is in engagement with said cylindrical portion of said envelope.

4. A switch as defined in claim **1** in which said pendulous contact is a helically wound wire with the helix closely wound, the wire being of a diameter of the order of .003 inch.

5. A switch comprising:

(a) a dielectric base having a cylindrical portion;

(b) a cylindrical dielectric envelope closed at one end and having its other end closed by the cylindrical portion of said base extending into said envelope;

(c) a pair of electrodes cast in said base and extending axially therethrough, one of said electrodes being positioned to extend axially in contact with the inner surface of said envelope and the other of said electrodes being positioned on the central longitudinal axis of said envelope;

(d) a ring contact formed on the end of said first mentioned electrode, said ring contact being in engagement with and supported by the inner cylindrical wall of said envelope; and

(e) a coil spring of resilient current conducting material, said spring consisting of closely wound helix, said pendulous contact extending through said ring contact, and including means whereby said pendulous

contact engages said ring contact when subjected to a force adequate to cause said pendulous contact to cantilever into engagement with said ring contact.

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